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THE UNIVERSITY OF ALBERTA

DIRECTED, NON-DIRECTED AND PROLONGED VISUAL SEARCH OF NORMAL AND RETARDED CHILDREN

by

© GARY EDWARD TORBIT

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF EDUCATION

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

EDMONTON, ALBERTA

FALL, 1970

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Directed, Non-Directed and Prolonged Visual Search of Normal and Retarded Children" submitted by Gary Edward Torbit, in partial fulfilment of the requirements for the degree of Master of Education.

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ABSTRACT

Corneally reflected eye movements (EMs) of 30 educable mentally retarded (EMR) and 30 normal children, nine to twelve years of age, were compared to determine if differences existed in their looking responses to picture stimuli. Eye movements were compared under three task conditions, namely, non-directed search, verbally directed search, and non-directed prolonged search.

The results indicated that when gross inattentive looking responses (unscorable frames) are included in the data, normal Ss recorded a greater information search score (ISS) and fewer unscorable frames than EMRs, under all task conditions. When gross inattentive looking responses were deleted, normal Ss still maintained the higher ISS on all tasks except the non-directed search task. No significant differences in EM activity associated with duration of fixation, and tracklength between successive fixations were found between EMR and normal Ss under any task conditions.

It was concluded that EMR children tend to experience more difficulty than normal children in controlling their visual search behavior. These difficulties could be regarded as detrimental to the effectiveness of their selective attentive behaviors. The results appear to be consistent with previous research which has pointed to the retarded child's tendency to respond to extraneous stimuli, his ease of habituation to repeated stimuli, and his inability to allow verbal signal stimuli to maintain active attention as effectively as in normal children.

LIST OF CONTENTS

CHAPTER PAGE

I INTRODUCTION 1

Attention - Some Problems of Definition. . 1

Attention and Mental Retardation . . . 5

Attention and Eye Movements 7

II SOME RELATED LITERATURE 10

Eye Movements and Cognitive Activity . . 10

Eye Movements and Perceptual Development . 11

Eye Movements and Mental Retardation . . 13

Eye Movements and Verbal Instructions . . 16

General Statement of the Problem . . . 18

III DEFINITIONS AND HYPOTHESES 19

Definitions 19

Hypotheses 20

IV METHOD 23

Subjects 23

Apparatus 24

Rationale For Tasks and Stimulus Materials . 25

Experimental Design 27

Rationale For Response Measures and Response Criteria 28

CHAPTER PAGE

Calculation of Dependent Variables . . . 32

Procedure 34

V RESULTS 36

Hypothesis 1 36

Hypothesis 2 47

VI DISCUSSION, IMPLICATIONS AND SUMMARY . . . 54

Discussion 54

Implications 61

Summary 63

REFERENCES 67

APPENDICES 73

APPENDIX A - Description of the X-Y Plotter and Scoring Procedure 73

APPENDIX B - Instructions for Judges' ISS Rating . . 74

APPENDIX C - Task Instructions Given to Subjects . . 79

APPENDIX D - Duration and Tracklength Means and Analysis of Variance for the 30 Scorable Frame Criterion under the NDS, DS-IP and DS-RP Task Conditions 82

APPENDIX E - Duration and Tracklength Means and Analysis of Variance for Initial and Final 30 Scorable Frames of the Prolonged Search Task . . 85

LIST OF TABLES

TABLE PAGE

1 ISS MEANS FOR THREE SECOND CRITERION, AND ANALYSIS OF VARIANCE 37

2 UNSCORABLE FRAME MEANS FOR THREE SECOND CRITERION, AND ANALYSIS OF VARIANCE . . . 39

3 ISS MEANS FOR 30 SCORABLE FRAME CRITERION, AND ANALYSIS OF VARIANCE 41

4 ISS MEANS FOR INITIAL THREE SECOND AND FINAL THREE SECOND CRITERION OF PROLONGED SEARCH TASK, AND ANALYSIS OF VARIANCE 48

5 UNSCORABLE FRAME MEANS FOR INITIAL AND FINAL THREE SECOND CRITERION OF PROLONGED SEARCH TASK, AND ANALYSIS OF VARIANCE 50

6 ISS MEANS FOR INITIAL AND FINAL 30 SCORABLE FRAME CRITERION OF PROLONGED SEARCH TASK, AND ANALYSIS OF VARIANCE 51

CHAPTER I

INTRODUCTION

The current study was an investigation of some visual aspects of the attentive behavior of normal and educable mentally retarded (EMR) children, using eye movements (EMs) as the dependent variable, under conditions of non-directed search (NDS), verbally instructed tasks, and non-directed prolonged search (NPS).

Attention - Some Problems of Definition

It is apparent that while the organism's sensory receptors are exposed to a large number of stimuli coming from the external environment, the organism responds to only a small proportion of these stimuli at any given time. In effect, the organism appears to act selectively upon the totality of stimuli impinging upon its receptors. Yet, despite the fact that attention has sporadically interested psychologists since the dawn of experimental psychology, the explicit nature of the phenomenon has historically eluded precise empirical account.

A controversy concerning the function of attention may be traced to the influence of the Functionalist and Structuralist schools during the latter part of the 19th century. The Functionalists (James, 1890) conceived of attention as an active process whose function, dependent upon the past experiences and interests of the organism, was selection; while the Structuralists (Titchener, 1908) identified attention with the intensification of

sensory clearness in conscious thought. With the advent of behaviorism, during the early 20th century, the concept of attention became unpopular; but subsequent definitions of attention, while centering around the responses of the organism, have tended to emphasize selective processes. For example, Guthrie (1952, p. 53) explained attention in terms of "a variety of responses that orient the sensory receptors toward certain stimuli," and Skinner (1961, p. 122) concluded that attention is the "control exerted by a discriminative stimulus." Hill (1963) described attention as an interaction of the past experiences of the organism and the present stimulus situation, while Samuels (1967) defined attention as the ability to refrain from responding to irrelevant stimuli, and Triesman (1969) as the selective characteristic of perception and responses.

Despite the interest in selective aspects of attention, recent years, with their advances in psychophysiological methods, have seen experimental examination of intensive characteristics of attention. Indeed, after an extensive review of the literature Berlyne (1960) stated that attention is generally thought of as something with both _selective_ and _intensive_ characteristics. Berlyne (1960, p. 45) states:

> it...(attention)...has been used to describe the processes that determine which elements of the stimulus field will exert a dominating influence over behavior, as well as processes that determine an organism's degree of alertness or vigilance (i.e., how effectively behavior is being controlled by the stimulus field as a whole).

Neurophysiological evidence for the necessity of a selective

component has been provided by information theorists (Sherrington, 1906; Miller, 1956; Broadbent, 1966; Luce, 1960) who explain that the channel capacity of the efferent pathways is less than that of the afferent system, hence man can respond to only part of the stimuli impinging upon him at any given time. Whenever the potential influx of information from the sensory receptors over-rides channel capacity the limits to conduction can be maintained either by transmitting everything that is coming in from one source and blocking the other receptors, or by partial transmission of information from several sensory receptors.

Another interesting development which appears to be providing further clarification of both the intensive and selective phenomena associated with attention comes from Soviet research on the orienting reaction (OR). The OR appears to be a complex of vegetative and skeletal changes (e.g., GSR, head movements and eye movements) in response to unexpected stimuli (Berlyne, 1966; Sokolov, 1966), which contribute to the general state of arousal of the organism, and direct the receptors toward the source of the stimuli. Soviet psychologists are of the opinion that the OR must precede the learning of any new response. They argue that it is associated with intensification of activity in cortical centres responsible for the intake and analysis of sensory information, and in the habituation of repetitive stimuli. For instance, when an unexpected stimulus has been sufficiently explored to be disregarded or responded to in any specific way the OR will diminish and finally fail to occur (i.e.,

habituate). Repeated or prolonged presentation of a stimulus, then, results in the gradual habituation of the OR (Sokolov, 1963; Berlyne, 1966; Hebb, 1966).

With regard to the selective aspects of attention, the implications of Soviet views on the OR are not definitive since they do not choose to discriminate sharply between perception and attention. Indeed they use the concepts of orienting responses and orienting-investigatory activities interchangeably, though we could regard these processes as more or less objective counterparts of attention and perception (Berlyne, 1967). Western psychologists, however, (Jeffrey, 1968) prefer to treat the OR as an integral component of both the processes of attention and perception. The OR, in this view, is considered a first and necessary condition for attention, its presence not necessarily implying that the subject has acted selectively upon the stimulus, nor that specific information about the stimulus has been obtained. The scanning of information would be defined as attention, while the identification of the selected information would appear to be a function of perception (Reese and Lipsitt, 1970).

It is apparent that the processes of OR, attention and perception are functionally related. Further empirical investigation will be required to determine the explicit relationship between these three processes. Selective attentional processes, too are no doubt related to orientation and perception. Nevertheless, it does appear that some aspects of these selective processes may be meaningfully

investigated and measured in terms of what could be called looking behavior. Such behavior could be defined in terms of certain specific eye-movement measures.

Attention and Mental Retardation

For many years, those with educational and clinical experience have tended to identify impairment of attention as a general trait of the mentally retarded. Behavioral descriptions of this group commonly include "inability to concentrate," "distractibility" or "short attention span" (Kuhlman, 1904; Strauss, 1955, 1957) as educationally relevant characteristics. Yet Martin (1967) mentions that studies with normal children suggest that deficiencies in attention may be task and child specific rather than a characteristic of retardation *per se*.

While an attentional deficiency might be anticipated on the basis of a generally slower rate of neurological development, or on a learning environment which prevents the acquisition of appropriate attentive skills, a number of theorists have attributed this deficit, in retardates, to defective cortical functioning. Denny (1966) observed that attentional deficiency was a manifestation of a more basic deficit in inhibition which renders the retarded "stimulus bound." Luria (1963) proposed that a disturbance between excitatory and inhibitory processes in retardates, with excitation predominating, results in their inability to refrain from responding, thus producing distractable and impulsive behavior. It is worth noting, furthermore,

that several writers (Luria, 1963; Berkson, 1963, and Karrer, 1966) reported an absence or diminished OR to certain stimuli, in retardates, and a failure to habituate the OR to strong stimuli. Lindsley (1957) has also speculated that retardates may suffer from dysfunctioning of certain sub-cortical centres with concomitant disruption of normal arousal and activating processes.

Although there is some neurological and overt behavioral evidence of impaired attentive responses among retardates who sustain organic impairment, Crosby and Blatt (1968, p. 76) contend that there is little evidence of any necessary correlation between brain damage and attentional deficiency, and no convincing support for the proposition that retardates require a different educational methodology from other children. They argue further that while a positive correlation between intelligence and the ability to maintain attention to a task was assumed by many early mental test developers, the few studies made of this relationship have failed to confirm this hypothesis.

It is evident, from the above discussion, that while there is consistency in the literature for an attentional deficit in the mentally retarded, there has been insufficient empirical investigation of the behavioral manifestations of attentional deficiency which would permit both a valid measure of attentional processes and the development of remedial methods and programs.

House and Zeaman (1967), and O'Connor and Hermelin (1963)

have argued that an inability to attend to relevant stimulus cues may account for the learning disabilities in moderately retarded children. Yet the method used by House and Zeaman to assess this hypothesis has been criticized by Mostofsky (1968) for failure to select a dependent variable as an external referent for attention, independent of the overt instrumental response. Circularity was evident, then, in the House and Zeaman assumption which involved a task requiring learned behavior in order to arrive at a measure of attention (Wischner, 1967). Wychoff (1952) proposed that observing responses would be a valid measure of attention since looking behavior can be independently controlled and operationally defined.

Attention and Eye Movements

It is readily observed that when the organism is confronted with an unexpected stimulus, receptor-directing movements in posture occur in order that full investigation of the stimulus may be made. Such responses as head and eye movements are required, then, to aim the sense organs at the stimulus in question and away from irrelevant stimuli. These responses are apparently of a selective nature, and any method which would record the looking behavior of the organism, in response to a stimulus, could be said to provide a relatively objective measure of the selective component of attentional processes. For purposes of this study, then, corneally reflected eye movements were used as the dependent variable.

To summarize, the selection of literature cited suggests that

while psychologists fail to agree as to the explicit nature of attention, recent investigations of the activities of certain subcortical centres and Soviet studies of the OR appear to be providing empirical clarification for both the intensive and selective phenomena historically attributed to the concept of attention. While Soviet psychologists do not clearly differentiate between attention and perception, their Western counterparts generally treat attention as an intermediary between the OR and perception. According to the latter view attention is defined as scanning (looking) behavior. The heuristic value of these studies for the concept of attention, particularly the Soviet work on the OR, lie in the provision of dependent variables (i.e., eye movements) which may be independently measured and validated.

Evidence was also cited attributing the attentional deficiency sustained by retarded children to the dysfunctioning of certain subcortical centres associated with the manifestation of the OR, such that certain signal and nonsignal stimuli either fail to elicit or maintain the OR. The inability of the retarded child to select relevant stimulus cues has also been attributed to an attentional deficit.

Since many of the studies of attentional deficiency, in the retarded, involved children in institutionalized settings, many of these findings may or may not be applicable to educable mentally retarded children in a regular classroom. The implication of an

attentional deficiency is most relevant in this case since the educable mentally retarded constitute the largest proportion of the mentally retarded population.

CHAPTER II

SOME RELATED LITERATURE

The phenomenon of attention, as discussed in chapter I, was shown to be the manifestation of perceptual processes which determine what will be selectively input. The influence of perception on peripheral processes, such as eye movements (EMs), is not yet explicit. In the present chapter, studies of the relationship between EMs and (1) cognitive activity, (2) perceptual develoment, and (3) mental retardation have been selected in order to explore the nature of *looking behavior* which may be indicative of attentive behavior.

Eye Movements and Cognitive Activity

Some studies with normal *Ss* have suggested that EMs are integrally related to cognitive functioning. For example, Luborsky, Blinder and Mackworth (1964) studied the relationship between inspection time of part of the visual field attended to and accuracy of recall of perceptual images. It was observed that the greater the frequency of EMs the more accurate the recall. Similarly, in a vigilance study Mackworth, Kaplan and Metlay (1964) demonstrated that *Ss* manifesting the greater frequency of EMs detected more signal stimuli. The duration of EMs, then, appeared to be related to cognitive processing.

It is evident, nevertheless, that stimulus characteristics

will themselves influence the duration variable. For instance, Ford, White and Lichtenstein (1959), concluded, in a study of EMs during free search, that duration varies with the difficulty of the field and that specific search patterns could probably be isolated from EM recordings. Teichner and Price (1966) hypothesized that EMs resulting in the obtaining of new information would represent a data acquisition process which might be divisible into the testing of assumptions and gross exploratory movements. They observed that with college students correct solutions in sequence concept tasks tended to be associated with a reduction in scanning behavior and increased attention to detail. Krugman (1968) also found a relationship between scanning (i.e., 'spread-out looking') and learning, which suggests that certain looking responses may be better than others with regard to a discrimination learning task. The assumption of a visual search strategy, however, has not been verified at an operational level.

Eye Movements and Perceptual Development

Several studies with normal Ss have suggested a functional relationship between EMs, in cognitive activities, and the developmental nature of visual perception. Zaporozhets and Zinchenko (1966) have contributed to our grasp of this developmental issue. Using children three to six years of age, they concluded that perceptual development "proceeds along the line of isolating a specific sensory content which is increasingly more commensurate with the material

being presented and the task with which the subject is faced" (1966, p. 398). These researchers found that within the age range of their sample, six-year-old children exhibited diminished exploratory EMs and increased concentration on the more informative parts of the stimulus object.

Some Western psychologists support the ontogenetic argument with respect to EM behavior. Mackworth and Bruner (1966), for example, have reported differences in the EMs of children and adults in the detection and selection of visual information. These differences were also regarded as being developmental in nature, and related to the information search strategies of the Ss. More specifically, they found the EMs of children to be less consistent than those of adults in locating the informative areas of out-of-focus scenes, such that children exhibited "piece-meal" perception by dwelling on unimportant details. The authors concluded that children cannot draw on experiences as can adults to guide them towards the important perceptual cues of a stimulus. Similarly, in Gilbert's (1953) study, EM measures were obtained for frequency of fixation and pause duration of children from Grades one to nine. A steady growth in ocular motor proficiency, such that fewer fixations and longer pauses were recorded by the older children. The implications may be that while better control over EMs is being developed with respect to the skill of reading, previous experience with written symbols permits greater input at each fixation, hence the longer pauses.

A recent developmental study was conducted by Mackworth and Otto (1970) of the visual orienting responses to novelty, and its habituation. Using children two to seven years of age, they revealed that two-year-olds orient just as effectively as seven-year-olds to simple stimuli and that increasing age did not significantly alter the rate at which the group fixation times decline during the habituation phase of the experiment. In discussing this seemingly contrary finding the writers explained that greater differences between age groups might occur when more complex thinking processes are required to interpret the stimuli.

The above studies are particularly relevant to the current enquiry since higher etiological categories of retardation (i.e., retardates not suspected of organic brain dysfunctioning), such as EMRs, are defined on the basis of a substantially developmental criterion (i.e., IQ). Hence the looking responses of EMRs could simply be indicative of more primitive manifestations of perceptual development. It would appear, however, that the nature of a person's looking behavior is integrally related to the qualitative and quantitative complexity of the individual's previous learning experience, and as such, may be relatively task and stimulus specific.

Eye Movements and Mental Retardation

Eye-movement studies in the field of mental retardation are relatively few in number, particularly those having any direct relevance for this study. Among these few, Rosenberg (1961)

demonstrated that severely retarded patients took longer to detect and select a nonsense shape from a matrix than did moderately retarded patients. Similarly, evidence of an inability on the part of mental retardates to effectively control their observing responses has been reported by Blackhurst and Radke (1966). These investigators found that mentally retarded children have difficulty in fixating objects and controlling visual search behavior. Dunn (1954), however, compared the EMs of retarded and normal boys of similar mental age engaged in reading tasks and reported no significant differences in rate of reading, fixations, and regressions between the two groups. Dunn does not report comparisons between retarded and normal boys of the same chronological age, and one might predict that they would display differences similar to those found by Gilbert (1953) between normal children of different chronological (and by implication, mental) age. In studies such as these, however, it might also be argued that any differences in EMs is reflecting the retarded group's inability to read at their chronological age level rather than this being a causative factor in their mental development.

O'Connor and Hermelin (1963) are of the opinion that the learning difficulties of the moderately retarded result from an inability to focus attention on relevant stimuli rather than poor perception, retention, or transfer. Similarly, House and Zeaman (1967) maintain that an inability to attend to relevant cues, rather than low intelligence, may account for the learning disability of

moderately retarded children in discrimination learning tasks. Further, they suggest that if the attentive behaviors of moderately retarded children could be effectively controlled there would be no differences between these children and normal children in their rates of learning. The authors also point out that this deficit in attention might be best understood in terms of their scanning behaviors (House and Zeaman, 1967, pp. 192-212).

In contrast to a developmental basis for attention deficiency, there is some suggestion that the attentional problems of the mentally retarded could have a different basis. Shif (1969) concluded, after reviewing Soviet research on the rapidity of visual perception between normal and oligophrenic children, that "a slowdown in perceptual processes appears to be a definite characteristic of oligophrenic children" (1969, p. 329). Shif does not specify whether the slower rate of perceptual activity also has implications for the activity of the visual analyzers. But it would appear that since such analyzers do not operate independently of perceptual processes some degree of functional similarity may be evident.

To summarize, the selection of eye-movement literature cited suggests that the looking responses of individuals may differ as a function of past experience, and the nature of the task and stimulus material. Further, there would appear to be a developmental sequence associated with effective perceptual behavior characterized by a reduction in scanning or exploratory EMs on irrelevant stimuli, and

increased concentration on relevant stimulus cues, as a function of age. Moreover, it appears that retarded children may experience a more fundamental difficulty than normal children in the ways they attend to and process perceptual and cognitive stimuli.

Eye Movements and Verbal Instructions

The possible effects of verbal instructions (signal stimuli) upon attentional and investigatory behavior are of particular interest to the educator. Evidence that looking responses are changed by appropriate instructions, this change being reflected by changes in investigatory activity, has been reported by Karpov and Yarbus (1966) and Yarbus (1967). In addition, Luria and Vinogradova (1963) concluded that retarded children do not respond to signal stimuli, under verbal instructions, in the same manner as normal children. More specifically, they found that the unreliability of the OR in retarded children results in their inability to maintain attention to the task. Luria *et al.* (1963) observed that such behavior does not depend only on committing the instructions to memory. Even simple instructions fail to maintain the OR, although the motor responses to the signal stimuli are preserved. In essence, Luria *et al.* point to the retarded child's inconsistency of active attention and lack of perserverance, as being a most serious obstacle preventing his successful instruction. Shif (1969), however, states that a number of studies (not referenced) indicate "that perception...(of oligophrenics)...reaches a greater degree of accuracy and that the practical activity

associated with this perception is raised to a higher level if the perception and the activity are controlled by a concrete, guiding, verbal instruction" (1969, p. 331). More research will be required to permit confident interpretation of the latter two studies. In the meantime, the two possibilities suggested are that retarded children have less success in directing their activity under verbal instructional stimuli than normal children. Secondly, that the performance of retarded children does improve qualitatively when they have been able to attend to such stimuli.

The power of verbal instructions to coordinate the activity of the sensory receptors appears to be a developmental phenomenon. Lynn (1966) found that orienting or investigatory behavior emphasizes different sense modalities at different age levels, with vision becoming increasingly dominant. The influence of verbal instructions on performance has also been found to vary according to the age level of the children (Schopler, 1964). With younger children (less than five years) verbal instructions were effective only if while they were listening, they were looking at the features of the task at hand. Yet instructions of this kind were effective with older children regardless of where they were looking. Schopler, however, does not report any changes in actual EMs as a result of verbal instructions. Lorens and Darrow (1962) found that the rate of EMs was significantly increased as a result of instructing Ss in the solution of arithmetic problems, but again, such behavior may be more or less task and stimulus specific.

Evidence of the ineffectiveness of verbal instructions in maintaining the active attention of severely retarded children may have implications for higher etiological subgroups of retardation such as the educable mentally retarded (EMR). Since a large proportion of the daily classroom activities are verbally communicated, and many of the instructional methods and materials employed necessitate efficient maintenance of observing responses, doubt as to whether the observing responses of EMRs are being effectively coordinated under verbally directed stimuli, for any reasonable period of time, would seem important to investigate. Any evaluation of qualitative differences, however, would require that looking responses be investigated under relatively non-directed task conditions.

General Statement Of The Problem

The purpose of this study was to determine whether differences existed in the looking behaviors of normal and educable mentally retarded (EMR) children, using corneally reflected eye movements (EMs) as the dependent variable. The EMs of the two groups were compared under (1) a non-directed search task, (2) two verbally instructed tasks, and (3) a non-directed prolonged search task condition. The specific dependent EM measures included (1) an informative search score (ISS), (2) the number of unscorable frames, (3) the duration of scorable fixations, and (4) the tracklength between successive scorable fixations.

CHAPTER III

DEFINITIONS AND HYPOTHESES

Definitions

Fixation. One or more successive corneal reflections within a circular area 11.4 mm. in diameter on the stimulus material at a viewing distance of 24 inches. A fixation is completed when the corneally reflected light spot has shifted at least 5.7 mm. (an amount which represents the calculated margin of recording error on the EM recorder).

Duration of fixation. The number of frames (each frame represents 1/10th of a second of recording) per scorable fixation.

Tracklength. The distance between successive scorable fixations, measured in mm..

Informative Search Score (ISS). The sum of the cell weights for any particular stimulus multiplied by the number of corneally reflected light spots within the cell during any given time period. The weights are the mean values obtained by having a group of judges independently rate each cell in a 7 x 7 matrix superimposed upon the stimulus field, on a 6-point scale, relative to the importance of the information content in any given cell.

Unscorable frames. Those frames in which the corneally

reflected light spot is either visible but outside the calibrated boundaries of the stimulus material, or not visible. Principal reasons for the spot not being visible are eye blinks and excessively rapid EMs at the instant of frame exposure.

Hypotheses

Rationale. A number of studies (Blackhurst and Radke, 1966; House and Zeaman, 1967) have suggested that retarded children experience difficulty fixating objects, attending to relevant stimulus cues, and generally controlling their visual search behavior. Further, there is evidence to the effect that verbal instructions fail to maintain the attention of retarded children in the same manner as in normal children (Luria and Vinogradova, 1963).

Postulate 1. Under relatively non-directed search (NDS), and directed search tasks involving picture recall (DS-RP) and incomplete picture instructions (DS-IP), differences in the EM behavior between normal and EMR children will favor the normal children. These differences might be understood to represent differences in the effectiveness of selective attention. Thus the normal children will record fewer gross inattentive EMs and select areas of a stimulus of higher information value than will EMR children. In effect, then, normal children may be expected to command a longer duration of EM fixation and shorter tracklength between successive scorable fixations on the stimulus materials due to the apparent difficulty of retarded children in controlling their looking behavior.

Hypothesis 1. Normal children will record a significantly:

a. greater mean ISS

b. fewer mean number of unscorable frames

c. longer mean duration of EM fixation

d. shorter mean tracklength between successive EM fixations, under the NDS, DS-IP and DS-RP task conditions, than will the EMR children.

Rationale. Repeated or prolonged exposure of a stimulus results in the gradual habituation of the OR (Sokolov, 1966; Hebb, 1966). Further, Luria (1963) has found that retarded children habituate their OR to stimuli of certain intensities more quickly than do normal children. Since the OR appears to be integrally related to attentive behavior, the implication of OR habituation for the looking behavior of EMR and normal children would seem important to investigate.

Postulate 2. The looking behavior of normal children will be more effective than that of EMR children, after a period of exposure to picture stimuli, under a relatively non-directed search (NDS) task condition.

Hypothesis 2. Normal children will record a significantly:

a. greater mean ISS

b. fewer mean number of unscorable frames

c. longer mean duration of EM fixation

d. shorter mean tracklength between successive EM fixations over the final period of a 60 second interval of continuous exposure to picture stimuli, than EMR children, on the non-directed prolonged search task.

CHAPTER IV

METHOD

Subjects

Forty-four educable mentally retarded (EMR) and 41 normal children, with chronological age (CA) within the range of nine to twelve years, participated in the experiment. The EMRs were defined as those Ss obtaining a Full Scale IQ score between 50 and 80 on the WISC (Mean = 70, S.D. = 7.43), and who were not known to have incurred any organic defect or severe emotional problems. The normal children were defined as those functioning at their appropriate age-grade placement, whose IQ (Mean = 118, S.D. = 9.85) was within plus or minus one-half standard deviation of the local mean of the Full Scale IQ of the WISC.

The EMRs were selected from the opportunity classrooms within the Edmonton Public School system, the normal Ss from regular classrooms. Potential Ss not approximating the standard 20/20 visual acuity criterion, as measured by the Snellen Chart, were not included in the sample, nor were those requiring the use of glasses or contact lens inasmuch as the measurement procedure will not tolerate the reflective characteristics of glass. Fourteen EMRs and 7 normal Ss were discarded from the sample due to an insufficient number of scorable frames. Four normal Ss were randomly eliminated from the sample to obtain equal n's of 30 in each of the two groups.

Apparatus

A Polymetric Products Eye-Movement Recorder (Model V-1164), employing the principle of corneal reflection was used to obtain permanent photographic records of the Ss eye movements (EMs). The Eye-Movement Recorder records EMs by means of a Pathe "Professional" reflex camera on 16 mm. film at a constant exposure rate of 10 frames per second (see Mackworth, 1967, for full technical details). The stimulus material is presented at a viewing distance of approximately 24 inches (slight variations occur due to different S's skull formations) from the S's eyes within a recordable viewing area of 7.8 x 7.8 inches. Recording accuracy was within plus or minus one degree when Ss view a 20 degree wide and 20 degree high display. Thus eye spot accuracy, under these experimental conditions, can be ascertained within an area having approximately 1 inch diameter.

In operation, the recorder is mounted on a wishbone-shaped base plate supported by a table. The apparatus consists of adjustable headrest and bite-bar. The subject is seated on an adjustable chair, and views the stimulus display with both eyes while biting on a dental impression made from Kerr Impression Compound. The recorder projects a light spot off the S's left cornea on to the stimulus display where it is photographically recorded.

A Sony tape recorder (Model TC-777-4J) and integrated amplifier (Model 1120) were used to supply specific instructions, at constant intensity, through a binaural headset. White noise of 65 dB intensity from a Marietta generator (Model 24-21B) was presented through a

binaural headset to mask the effect of extraneous auditory stimuli which may artifactually distract the Ss while the data was being collected.

The EM records were scored by means of an X-Y Plotter. The X-Y Plotter locates the horizontal (X) and the vertical (Y) coordinates of each corneally reflected light spot, recorded on 16 mm. movie film. These coordinates are simultaneously transmitted to an IBM card punch machine permitting an analysis of the information responded to by the Ss on the stimulus material. A computer program is then used to transform these coordinates into appropriate EM measures. A description of the X-Y Plotter and the specific scoring procedure employed in this study may be found in Appendix A.

Rationale For Tasks and Stimulus Materials

Four experimental conditions were presented to the Ss. First, a non-directed search (NDS) task was included to provide for measurements of looking responses under what might be called a relatively free search condition. Measurements of mean duration and tracklength of EM fixation, ISS, and number of unscorable frames recorded were used to determine whether the EMs of the retarded group were different from those of normal children in the absence of any directions requiring visual search behavior. As such, then, the NDS task provides for an objective comparison of the two groups' looking behavior under the succeeding verbally directed task conditions.

A non-directed prolonged search (ND-PS) task was designed to determine whether differences in looking behavior, between normal and EMR children, occur as a function of duration of exposure to picture stimuli. The task was designed, then, to explore the implications of habituation for the looking behavior of EMR and normal children. Those EM variables used in the NDS task were used to compare the EMs of the two groups under this task condition.

Two types of verbally directed tasks were included to provide for the measurement of looking responses under what might be called typical signal conditions for the manifestation of attention. A directed recall picture search (DS-RP) task required the Ss to verbally recall all the elements they had observed in each stimulus picture, while a directed incomplete picture search (DS-IP) task required the Ss to detect the missing element in each stimulus picture presented. Since these tasks appeared to require two different types of cognitive activity, and since there is no evidence to suggest that looking responses should be the same under the two tasks, they appeared to provide a reasonably objective basis for determining whether differences in EMs, between normal and EMR children, occur as a function of verbal instructions. The EM variables used in the NDS task were used to compare the two groups looking behavior under both the DS-RP and DS-IP tasks.

The stimulus materials used with respect to the NDS, ND-PS, and DS-RP task conditions were early 19th century Sam Slick (Haliburton, 1956) picture characterizations. A set of three

pictures was used in conjunction with each of the task conditions. The materials were selected due to their novelty, and the fact that they contained a considerable amount of information, hence, would likely be of interest to the Ss.

Three incomplete picture stimuli (i.e., boat, sun and woodpile) were selected from the Incomplete Picture subtest of the Wechsler Adult Intelligence Scale (Wechsler, 1959). The DS-IP task condition was selected, generally, to provide for the comparison of normal and EMR children's looking behavior under a type of verbal instruction differing from the DS-RP task. While interest, here, was not with correct solution, there is some suggestion that retarded children experience difficulty in selecting relevant stimulus cues (House and Zeaman, 1967). In this regard, the incomplete picture stimuli appeared appropriate due to their single stimulus value.

Experimental Design

A 2 x 3 analysis of variance design (Winer, 1962, p. 302) with repeated measures was employed, the factors being, respectively, classification (EMR and normal) and tasks (NDS, DS-RP and DS-IP) to analyze the data with respect to the variables of duration of fixation, tracklength between successive fixations, ISS, and number of unscorable frames recorded. Each S received a randomly ordered set of three pictures under each of the three task conditions. Similar, although not identical, picture stimuli were presented under the NDS and DS-RP tasks to provide some control over the effects of stimulus specificity

due to the nonrandomized presentation of non-directed and verbally directed search tasks. Each stimulus picture presented under the NDS, DS-RP and DS-IP task conditions was recorded for a five second interval.

A 2 x 2 analysis of variance design (Winer, 1962, p. 302) with repeated measures was used with respect to the ND-PS task condition. Under the ND-PS task, each stimulus picture presented on the NDS task condition was followed by a 50 second interval of non-recorded exposure, followed by a final five seconds of EM recording. The initial five second interval of the NDS task, then, combined with the final five second interval constituted the ND-PS task condition. The factors, then, under the ND-PS task were classification (EMR and normal) and time periods (initial and final five seconds). This design was also used for the EM variables of duration, tracklength, ISS and unscorable frames. The critical significance level chosen for this study was .05.

Rationale For Response Measures and Response Criteria

Since interest, in this investigation, focused upon the selective phenomena of attentive behavior, appropriate EM variables were required which would objectively measure, first, the proportion of looking responses being made to the stimulus field as a whole, and secondly, whether certain parts of the stimulus field were being responded to more frequently than other parts of the stimulus.

A methodological means for examining whether certain parts of a visual stimulus are being selectively responded to, relative to other parts of the stimulus material, has been suggested by previous eye-movement research (Conklin, Muir and Boersma, 1967; Mackworth and Bruner, 1966). Conklin _et al._ (1967) have defined this measure as an _Informative Search Score_ (ISS). The absolute ISS value would be a function of looking responses given to areas of the stimulus varying in amounts of information content.

The ISS value for each stimulus picture was determined by applying a 7 x 7 grid to each picture thereby partitioning the total area of the stimulus picture visible to the _Ss_ into 49 cells. Ten judges used a 6-point scale to rate each individual cell according to the amount of information which it contributed to the content of the picture as a whole. The specific instructions for rating the stimulus pictures with respect to task conditions may be found in Appendix B. A mean weight per cell was then calculated for each picture on the basis of the judges' rating. An analysis of variance incorporating the Spearman-Brown prediction formula (Winer, 1962, p. 127) was used to determine the reliabilities of the judges' rating. The unadjusted reliabilities over all stimulus materials used in the experiment ranged from .94 to .97.

Evidence of gross inattentive looking responses would be objectively measured by determining the number of _unscorable frames_ recorded while exposed to the stimulus material. While unscorable

frames can also occur due to eye blinks, loss of calibration and indistinguishable eye spots resulting from rapid movements at the instant of recording, these factors would not account for any appreciable difference in number of unscorable frames over the interval of EM recording. Thus unscorable frames may be regarded as measuring such inattentive responses as looking off the stimulus material.

The eye-movement recorder allows for the measurements of both duration of EM fixation and tracklength between successive EM fixations. While the specific relationship between these variables and selective processes of attention is not clearly understood, there was some suggestion in the literature that scanning behavior may be identified with the process of attention. Further, the phenomenon of selective attention suggests the ability to control the activity of the visual analyzers to some elements of a stimulus, as opposed to random exploratory movements. Again, however, the explicit nature of the relationship between such activity and the variable of duration and tracklength is not known. Moreover, it may be task and stimulus specific. However, measurements of duration and tracklength would provide an index for any differences existing in the EM activity with which EMR and normal children respond to the stimulus material. In this sense, these variables could provide some clarification for any differences occurring, between EMR and normal children, in absolute ISS value and number of unscorable frames recorded, as a consequence

of increased rate of EM activity with subsequent increases in distances between successive fixations.

Both duration and tracklength variables were used only with respect to scorable EMs, due to the artifactual introduction of increments in time of duration and distance of tracklength when procedures were employed to indicate the presence of an unscorable frame (see Appendix A for a detailed explanation).

It was suggested in the review of literature that were differences to exist between normal and EMR children, in their attentive behavior, such differences may be apparent, first, in their ability to selectively attend to the part(s) of the stimulus of high information value, and secondly, in their ability to maintain their looking responses on the stimulus field as a whole. Thus two procedures were employed to analyze the data.

Under the first procedure unscorable frames were deleted from the data and succeeding scorable frames (1 frame = 1/10 second) were accumulated to calculate an ISS mean for each set of 10 scorable frames. Hence a scorable frame criterion (30 scorable frames) was established to determine whether differences existed between the looking responses of EMR and normal children when the variance due to gross inattentive responses, such as looking off the stimulus field, is removed from the data.

The second procedure included unscorable frames in the calculation of the ISS mean, thus restoring a constant time base to the

data (i.e., 10 frames = 1 second). A time based criterion (first 3 seconds) was used, then, to determine the effects of gross inattentive responses on the ISS means of both EMR and normal Ss.

Each stimulus picture was presented for a five second interval of continuous EM recording. The rationale for selecting this time period was based on expense of filming and volume of data to be handled. An examination of the data for all subjects revealed that the five second interval provided a sufficient number of scorable frames to establish a 30 scorable frame criterion for investigating differences between groups when gross inattentive responses were removed from the data. A three second criterion included an equivalent number of frames for comparing the two groups when the variance due to inattentive responses was not removed from the data.

The ISS variable was calculated under both the 30 scorable frame and three second criteria, and the unscorable frame variable was determined, for the Ss, over a three second time base. The duration and tracklength variables were calculated under the 30 scorable frame criterion due to the introduction of an artifact into these two variables under a three second time base (see Appendix A).

Calculation Of Dependent Variables

Mean duration of fixation. The duration of fixation is determined for each S by summing the scorable frames recorded on each stimulus picture at criterion (30 scorable frames), and dividing this sum by the total number of scorable fixations. The mean

duration, for each S, represents the average over the set of three pictures presented in each task condition.

Mean tracklength. The tracklength is obtained for each S by summing the distances between successive scorable fixations recorded on each stimulus picture at criterion (30 scorable frames), and dividing this sum by the total number of scorable fixations. The mean tracklength, for each S, represents the average over the set of three pictures presented in each task condition.

Mean ISS. The ISS is determined for each S by multiplying the sum of the cell weights for each stimulus picture by the number of corneally reflected light spots within the cell under the 30 scorable frame and three second criteria. Under the three second criterion an unscorable frame receives a zero value and is included in the average ISS value, but under the 30 scorable frame criterion the average ISS does not include the zero weightings. The mean ISS, for each S, represents the average over the set of three pictures presented in each task condition, for both a three second and 30 scorable frame criterion.

Unscorable frame. The value of this variable represents the sum of all unscorable frames recorded by each S over the set of three stimulus pictures, under each task condition, for a three second time period.

Procedure

The experiment was conducted in a specially constructed, sound attentuated, EM laboratory in which illumination control and equipment preparation facilities were provided.

Prior to the commencement of the experimental procedure all *Ss* were given an explanation as to the types of apparatus to be used in the experiment, and time was taken for the establishment of rapport.

At the commencement of the experiment the *S* was seated at the EM recorder and a dental impression, covering the bite-bar, was made. At the same time, a headset was adjusted and the *S* cautioned about head movements which would result in the loss of calibration. For a more detailed procedural description of the recording of corneally reflected eye movements, using the Mackworth stand-mounted eye movement recorder, the reader is referred to an article by Boersma and O'Bryan (1970).

The psychological effect anticipated by the random assignment of non-directed and directed tasks, on the looking behavior of the *Ss*, necessitated the presentation of the NDS and ND-PS tasks prior to the DS-RP and DS-IP task conditions. The order of presentation of the DS-RP and DS-IP tasks were randomly assigned to each *S*. While all instructions were presented over a headset, a sample stimulus from the DS-IP task was presented to all *Ss* before the task was begun to assure that *Ss* understood the instructions for the DS-IP task condition.

The EM recorder was calibrated for each S prior to the presentation of each stimulus picture. Calibration consisted of presenting a target card upon which both focusing and vertical and horizontal allignment of the corneally reflected light spot could be obtained. An experimental assistant acting upon a signal from the experimenter (E) removed, first, the calibration card and finally the stimulus picture at the end of the appropriate time interval. Following a brief rest period the EM recorder was recalibrated and the next stimulus picture presented.

Each S received a randomly ordered set of three stimulus pictures under each task condition, for a five second interval per picture. Under the NDS task each stimulus was recorded for the five second interval then the EM recorder was stopped for a 50 second interval, the S being continuously exposed to the stimulus material, then a final five seconds of EM recording was made of the stimulus picture. The initial five seconds and final five seconds of this task constituted the ND-PS task condition. The S then randomly received the DS-RP and DS-IP tasks. The instructions received by Ss for each task condition are presented in Appendix C.

CHAPTER V

RESULTS

Hypothesis 1

The results of the 2 x 3 analysis of variance with repeated measures on NDS, DS-IP and DS-RP task conditions, under the three second criterion, for ISS and unscorable frame variables are shown in Tables 1 and 2, respectively. While significant ISS main effects for groups ($F = 7.87$, $df = 1/58$, $p = 0.007$) and tasks ($F = 46.38$, $df = 2/116$, $p = 0.000$) were revealed by the analysis, the interaction effect between groups and task conditions was not statistically significant.

Planned orthogonal comparisons between group means, under the three second criterion, indicated that normal Ss recorded a greater ISS mean than did the EMRs on the NDS ($t = 1.76$, $df = 58$, $p < .05$)[1], DS-IP ($t = 2.65$, $df = 58$, $p < .01$) and DS-RP ($t = 3.99$, $df = 58$, $p < .001$) task conditions.

Orthogonal contrasts between task means, under the three second criterion, showed that both EMR and normal Ss obtained a greater ISS mean on the NDS task ($p < .001$) than was recorded under the DS-IP task condition. No significant differences in ISS, however, were recorded by either EMR or normal Ss between the NDS and DS-RP task conditions. Both normal Ss and EMRs obtained a greater ISS mean ($p < .001$) on the DS-RP task than was recorded under the DS-IP task condition.

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[1] Critical t (.05), df = 58, = 1.67 (one-tailed).

TABLE 1

ISS MEANS FOR THREE SECOND CRITERION, AND ANALYSIS OF VARIANCE

(a) ISS Means for 3rd Second

Groups	N	NDS	DS-IP	DS-RP
EMR	30	101.456	82.320	98.305
Normal	30	106.493	89.774	109.614

(b) Summary Analysis of Variance

Source	df	MS	F	p
Between Groups	59			
Groups (A)	1	2831.837	7.87	0.007
Subj. w. Grps.	58	360.069		
Within Subjects	120			
Tasks (B)	2	6423.281	46.38	0.000
A x B	2	150.410	1.09	0.431
B x Subj. w. Grps.	116	138.491		

Significant main effects for groups ($F = 4.68$, $df = 1/58$, $p = .04$) and tasks ($F = 4.99$, $df = 2/116$, $p = .008$) were indicated in the analysis of the unscorable frame variable. The interaction between groups and task conditions with respect to this variable, however, was not statistically significant (see Table 2).

Orthogonal contrasts between group means, under the three second criterion, revealed that the normal Ss recorded fewer unscorable frames than did the EMRs under the NDS ($t = 2.39$, $df = 58$, $p = .01$), DS-IP ($t = 2.22$, $df = 58$, $p < .05$) and DS-RP ($t = 2.60$, $df = 58$, $p < .01$) task conditions.

Orthogonal comparisons between task means indicated that significantly more unscorable frames ($p < .01$) were recorded by both EMR and normal Ss on the DS-IP task than were recorded under the NDS task condition. No significant differences, however, in unscorable frames between NDS and DS-RP tasks were recorded by either normal Ss or EMRs. Significantly more unscorable frames were obtained on the DS-IP task, by normal Ss ($p < .05$) and EMRs ($p = .05$), than were recorded under the DS-RP task condition.

The results of the 2 x 3 analysis of variances, under the three second criterion, suggests that EMR children experience more difficulty than normal children in controlling their looking responses, as evidenced by the greater number of unscorable frames recorded by the EMR group under all three task conditions of NDS, DS-IP and DS-RP. The greater incidence of gross inattentive responses (unscorable

TABLE 2

UNSCORABLE FRAME MEANS FOR THREE SECOND CRITERION, AND ANALYSIS OF VARIANCE

(a) Unscorable Frame Means

Groups	N	NDS	DS-IP	DS-RP
EMR	30	5.800	9.300	7.067
Normal	30	2.800	5.967	3.200

(b) Summary Analysis of Variance

Source	df	MS	F	p
Between Subjects	59			
Groups (A)	1	520.199	4.68	0.035
Subj. w. Grps.	58	111.121		
Within Subjects	120			
Tasks (B)	2	180.557	4.99	0.008
A x B	2	2.868	0.08	0.924
B x Subj. w. Grps.	116	36.142		

frames) would have contributed to the lower mean ISS recorded by the EMRs, under all three task conditions, as compared to the normal Ss.

The absence of any significant differences in ISS and unscorable frames between NDS and DS-RP task conditions suggests that a similar type of visual search strategy may have been elicited by the two tasks. These results, however, may also be stimulus specific. A lower mean ISS and greater number of unscorable frames recorded by both normal Ss and EMRs on the DS-IP task, as compared to both NDS and DS-RP tasks, would suggest that the DS-IP task required a different type of visual search behavior than was given under either the NDS or DS-RP task conditions. Again, stimulus specificity may have contributed to the lower ISS recorded under the DS-IP task, as compared to the NDS and DS-RP task conditions.

Under the 30 scorable frame criterion the effects of gross inattentive looking responses (unscorable frames) were removed from the data to determine whether differences existed in the selective attentive behavior, between EMR and normal Ss, with respect to those EMs being recorded on the stimulus material.

The results of the 2 x 3 analysis of variance, with repeated measures on NDS, DS-IP and DS-RP task conditions, under the 30 scorable frame criterion, revealed significant group ($F = 4.53$, df = 1/58, $p = .04$) and task ($F = 61.18$, df = 2/116, $p < 0.001$) main effects, with respect to the ISS variable (see Table 3), but no significant interaction effect. The results of the analyses for the duration and tracklength variables (see Appendix D) revealed no

TABLE 3

ISS MEANS FOR 30 SCORABLE FRAME CRITERION, AND ANALYSIS OF VARIANCE

(a) ISS Means for 30 Scorable Frames

Groups	N	NDS	DS-IP	DS-RP
EMR	30	108.764	91.237	106.624
Normal	30	109.933	94.107	113.888

(b) Summary Analysis of Variance

Source	df	MS	F	p
Between Subjects	59			
Groups (a)	1	638.438	4.53	0.038
Subj. w. Grps.	58	140.879		
Within Subjects	120			
Tasks (B)	2	5881.758	61.18	0.000
A x B	2	149.004	1.55	0.217
B x Subj. w. Grps.	116	96.138		

significant group main effects nor interaction effects for either variable. However, significant task main effects for duration ($F = 5.04$, $df = 2/116$, $p = .008$) and tracklength ($F = 8.68$, $df = 2/116$, $p < 0.001$) variables, under the 30 scorable frame criterion, were indicated.

Planned orthogonal comparisons between group ISS means, under the 30 scorable frame criterion, indicated no significant differences between EMR and normal Ss on the NDS task condition. The normal Ss did, however, record a significantly greater ISS under the DS-IP ($t = 1.69$, $df = 58$, $p < .05$) and the DS-RP ($t = 4.12$, $df = 59$, $p < .001$) task conditions, than did the EMRs.

Orthogonal contrasts between task means, under the 30 scorable frame criterion, revealed that both EMR and normal Ss recorded a greater ISS mean ($p < .001$) on the NDS task than was obtained under the DS-IP task condition. A shorter mean duration of fixation ($p < .01$) and longer mean tracklength ($p < .01$) was recorded by both EMR and normal Ss on the DS-IP task, as compared with the NDS task condition.

The normal Ss recorded a significantly greater ISS mean ($t = 2.23$, $df = 116$, $p < .05$)[2] on the DS-RP task, than was obtained under the NDS task condition, while similar differences were not statistically significant for the EMR group. A shorter mean duration of fixation ($t = 3.35$, $df = 116$, $p < .01$) and longer mean tracklength ($t = 2.01$, $df = 116$, $p < .05$) was recorded by the normal Ss on the

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[2] Critical t (.05), df = 116, = 1.66 (one-tailed).

DS-RP task than under the NDS task condition. No significant differences in duration and tracklength were recorded between the NDS and DS-RP tasks by the EMR group.

Both EMR and normal Ss obtained a greater ISS mean ($p < .001$) on the DS-RP task than was recorded on the DS-IP task. While mean duration of fixation between DS-RP and DS-IP tasks was not significantly different for the normal Ss, the EMRs maintained a shorter duration of fixation ($t = 2.23$, $df = 116$, $p < .05$) on the DS-IP task than under the DS-RP task. The normal Ss recorded a longer mean tracklength ($t = 3.33$, $df = 116$, $p < .01$) on the DS-IP task than under the DS-RP task condition, but similar differences in tracklength were not statistically significant for the EMRs.

When the effects of gross inattentive EMs (unscorable frames) were removed from the data, then, the EMRs obtained an ISS comparable to that of the normal Ss under the NDS task condition. The normal Ss, however, did record a significantly greater ISS on the DS-IP and DS-RP tasks, than did the EMRs.

While both EMR and normal Ss recorded a greater ISS on the NDS and DS-RP tasks, as compared to the DS-IP task, only the normal Ss attained a greater mean ISS on the DS-RP task than was recorded under the NDS task condition. Increased EM activity, associated with shorter duration of fixation and longer tracklength, was evident in the visual search behavior of normal Ss, under both the DS-IP and DS-RP tasks, in comparison to the NDS task condition. The EMRs

recorded a shorter duration of fixation and longer tracklength on the DS-IP task, as compared with the NDS task, but no significant differences in duration and tracklength were recorded by the EMRs between the DS-RP and NDS task conditions. The EMRs maintained a shorter duration on the DS-IP task, in relation to the DS-RP task, but similar differences were not significant for the normal Ss. The normal Ss recorded a significantly longer tracklength on the DS-IP task, as compared with the DS-RP task, yet differences in tracklength between DS-IP and DS-RP were not significant for the EMRs.

To summarize, the results of the 2 x 3 analysis of variance, under the three second and 30 scorable frame criteria, indicated that with the exception of the NDS task under the 30 scorable frame criterion, differences in ISS between EMR and normal Ss favored the normal Ss under NDS, DS-IP and DS-RP task conditions. While the EMRs recorded significantly more unscorable frames than normal Ss over all three tasks of NDS, DS-IP and DS-RP, no significant differences in duration of fixation and tracklength were recorded between EMR and normal Ss under the three task conditions. Further, no significant interaction between groups and tasks was recorded under either the three second or 30 scorable frame criteria.

While there was no significant difference in ISS between EMR and normal Ss on the NDS task, under the 30 scorable frame criterion, the fact that the EMRs recorded more unscorable frames than normal Ss on the NDS task suggested that the EMRs required more time (frames)

in which to attain an ISS comparable to that of the normal Ss.

Generally, the absence of any significant group differences in duration and tracklength, in addition to the fact that the EMRs recorded more unscorable frames than normal Ss over NDS, DS-IP and DS-RP task conditions, suggests that the EMRs not only experienced an inability to control gross inattentive looking responses but are less inclined to select areas of the stimulus of high information value, hence a lower ISS.

A shorter duration of fixation and longer tracklength was recorded by both EMR and normal Ss on the DS-IP task, in relation to the NDS task. This result suggested that the greater incidence of unscorable frames recorded by EMR and normal Ss, on the DS-IP task, may be attributed to increased EM activity; hence the lower ISS obtained by both EMR and normal Ss on the DS-IP task, as compared to the NDS task condition. Again, these results may be task and stimulus specific.

The fact that no significant differences in ISS and unscorable frames were recorded by either EMR or normal Ss, between NDS and DS-RP task conditions, under the three second criterion, had suggested that EMR and normal Ss had responded with a similar type of looking behavior under the two task conditions. The normal Ss, however, did record a greater ISS on the DS-RP task, as compared with the NDS task, under the 30 scorable frame criterion. Similar differences were not significant for the EMR group. Moreover, the normal Ss also recorded

a shorter duration of fixation and longer tracklength on the DS-RP task, in comparison to the NDS task, while similar differences were not significant for the EMR group. These results suggested, then, that the greater ISS recorded by the normal Ss, on the DS-RP task, could be attributed to increased EM activity.

Finally, both EMR and normal Ss recorded a significantly greater ISS mean on the DS-RP task than was recorded on the DS-IP task, under both three second and 30 scorable frame criteria. The fact that the EMR and normal Ss recorded more unscorable frames on the DS-IP task would have contributed to the lower ISS obtained on this task condition, under the three second criterion. Under the 30 scorable frame criterion, however, the EMRs recorded a significantly shorter duration of fixation on the DS-IP task, as compared to the DS-RP task, while similar differences were not significant for the normal Ss. Contrarily, the normal Ss recorded a significantly longer tracklength on the DS-IP task than was recorded on the DS-RP task, but similar differences were not statistically significant for the EMRs. These results may indicate that the lower ISS obtained by both EMR and normal Ss on the DS-IP task, as compared with the DS-RP task, are due to the differences mentioned with respect to duration and tracklength. It is more likely, however, that the differences in ISS, between the DS-IP and DS-RP tasks, represent differences in the nature of the task conditions and the type of stimulus materials used with respect to these tasks.

Hypothesis 1, then, was supported with respect to the direction predicted for ISS and unscorable frame variables, under the three second criterion. This hypothesis, however, was only supported with respect to the ISS variable on the DS-IP and DS-RP task condition, under the 30 scorable frame criterion, but was rejected for the duration and tracklength variables. In effect, the greater number of unscorable frames recorded by the EMRs over all three task conditions of NDS, DS-IP and DS-RP suggested that they experienced more difficulty in controlling their looking responses. Furthermore, when gross inattentive looking responses were deleted from the data, the normal _Ss_ recorded a greater ISS under the DS-IP and DS-RP tasks, than did the EMRs, which suggests that the normal _Ss_ were giving more looking responses to areas of the stimulus of high information value, than were EMRs. No differences in ISS, however, were recorded between EMR and normal _Ss_, on the NDS task, under the 30 scorable frame criterion.

Hypothesis 2

The results of the 2 x 2 analysis of variance with repeated measures on the ND-PS task condition, under the three second criterion, are presented in Table 4 with respect to the ISS variable. Significant ISS main effects for groups ($F = 6.97$, $df = 1/59$, $p = .01$) and task conditions ($F = 78.36$, $df = 1/58$, $p < 0.001$) were indicated by the analysis, but the interaction between groups and task conditions was not statistically significant.

TABLE 4

ISS MEANS FOR INITIAL THREE SECOND AND FINAL THREE SECOND CRITERION OF PROLONGED SEARCH TASK, AND ANALYSIS OF VARIANCE

(a) ISS Means for Initial and Final Three Second Criterion

Groups	N	Initial	Final
EMR	30	101.456	65.644
Normal	30	106.493	81.274

(b) Summary Analysis of Variance

Source	df	MS	F	p
Between Subjects	59			
Groups (A)	1	3204.375	6.97	0.010
Subj. w. Grps.	58	459.738		
Within Subjects	60			
Tasks (B)	1	27935.859	78.36	0.000
A x B	1	840.703	2.36	0.130
B x Subj. w. Grps.	58	356.524		

Planned orthogonal comparisons between ISS group means, during the final period of EM recording, revealed that the normal Ss obtained a significantly greater ISS ($t = 4.13$, $df = 58$, $p < .01$) under the three second criterion, than did the EMRs.

Table 5 shows the results for the unscorable frame variable, under the three second criterion. While significant main effects for groups ($F = 5.59$, $df = 1/58$, $p = .021$) and task conditions ($F = 43.62$, $df = 1/58$, $p < 0.001$) were found, the interaction between groups and task conditions was not significant.

Orthogonal contrasts between group means, during the final three second period of the ND-PS task, indicated that the normal Ss recorded significantly fewer unscorable frames ($t = 3.81$, $df = 58$, $p < .01$) than did the EMR group.

Scheffé contrasts between ISS means for the first three second and final three second period of the ND-PS task revealed that both EMR and normal Ss obtained a significantly lower ISS during the final three second period of the ND-PS task condition ($p < .01$) for both EMR and normal Ss).

Under the 30 scorable frame criterion (see Table 6) significant ISS main effects between groups ($F = 4.61$, $df = 1/58$, $p = .036$) and task conditions ($F = 31.69$, $df = 1/58$, $p < 0.001$) were indicated by the 2 x 2 analysis of variance. Further, a significant interaction between time period and groups ($F = 4.25$, $df = 1/58$, $p = .044$) was revealed by the analysis.

TABLE 5

UNSCORABLE FRAME MEANS FOR INITIAL AND FINAL THREE SECOND CRITERION OF PROLONGED SEARCH TASK, AND ANALYSIS OF VARIANCE

(a) Unscorable Frame Means

Groups	N	Initial	Final
EMR	30	5.800	26.367
Normal	30	2.800	16.133

(b) Summary Analysis of Variance

Source	df	MS	F	p
Between Subjects	59			
Groups (A)	1	1313.408	5.59	0.021
Subj. w. Grps.	58	235.052		
Within Subjects	60			
Tasks (B)	1	8619.086	43.62	0.000
A x B	1	392.388	1.99	0.164
B x Subj. w. Grps.	58	197.604		

TABLE 6

ISS MEANS FOR INITIAL AND FINAL 30 SCORABLE FRAME CRITERION OF PROLONGED SEARCH TASK, AND ANALYSIS OF VARIANCE

(a) ISS Means for Initial and Final 30 Scorable Frame Criterion

Groups	N	Initial	Final
EMR	30	108.764	87.381
Normal	30	109.933	100.015

(b) Summary Analysis of Variance

Source	df	MS	F	p
Between Subjects	59			
Groups (A)	1	1429.219	4.61	0.036
Subj. w. Grps.	58	309.965		
Within Subjects	60			
Tasks (B)	1	7347.656	31.69	0.000
A x B	1	986.250	4.254	0.044
B x Subj. w. Grps.	58	231.862		

It may be recalled that the ISS means for the initial 30 scorable frames of the ND-PS task also constituted the NDS task condition, under this criterion, and differences in ISS between EMR and normal Ss had not been significant. While both groups recorded a significantly lower ISS during the final 30 scorable frames, as compared with the initial 30 scorable frames, Scheffé contrasts of simple main effects revealed that this difference was significantly lower for the EMRs ($F = 29.58$, $df = 1/58$, $p < .01$) than the corresponding difference for the normal Ss ($F = 6.36$, $df = 1/58$, $.05 > p > .01$).

The results of the 2 x 2 analysis of variance for duration and tracklength variables revealed no significant group main effects or interaction effects for either variable (see Appendix E for the duration and tracklength analyses). However, significant task main effects for the duration ($F = 17.66$, $df = 1/58$, $p < 0.001$) and tracklength ($F = 41.97$, $df = 1/58$, $p < 0.001$) variables were indicated.

Scheffé comparisons of duration and tracklength means, between the initial and final 30 scorable frames, on the ND-PS task condition indicated that both EMR and normal Ss recorded a significantly longer duration and shorter tracklength ($p < .01$ for both variables) during the final 30 scorable frames.

Hypothesis 2, then, was supported with respect to ISS and unscorable frame variables, but not for duration and tracklength. While both groups gave significantly fewer scorable EMs during the

final three second period, the EMRs appeared to experience more difficulty than the normal Ss in controlling their visual search behavior, as evidenced by their greater number of unscorable frames.

Both EMR and normal Ss recorded a significantly longer duration and shorter tracklength during the final 30 scorable frames, than was recorded over the initial 30 scorable frames, suggesting that the lower ISS recorded by both groups during the final period was also due to reduced EM activity. Although no significant differences in duration and tracklength were recorded between EMR and normal Ss during the final 30 scorable frames, the difference in ISS recorded by the EMRs during the final period, as compared to the initial period, was significantly lower than the corresponding difference for the normal Ss. This result would suggest that since no significant group differences in EM activity were recorded, the EMRs were giving fewer looking responses to areas of the stimulus material of high information value, than were the normal Ss, during the final 30 scorable frames.

CHAPTER VI

DISCUSSION, IMPLICATIONS AND SUMMARY

Discussion

The results of this study suggest that the visual search behavior of normal children is more effective than that of EMR children under conditions of non-directed search, verbally directed search, and non-directed prolonged search. The differences in looking behavior of normal and EMR children were regarded as representing differences in the effectiveness of their selective attentive behaviors, and appear to support the conclusions of Blackhurst and Radke (1966) and House and Zeaman (1967) which suggested that mentally retarded children experience difficulty in controlling their visual search behavior and attending to relevant stimulus cues.

The normal children recorded a greater ISS and fewer inattentive EMs (unscorable frames), than did EMR children, under non-directed search, and verbally directed search tasks involving picture recall and incomplete picture instructions. Deleting the effects of unscorable EMs from the data revealed that the normal Ss had recorded a significantly greater ISS, than the EMRs, under the verbally directed task conditions, but not on the non-directed search task.

Differences in EM activity associated with duration of fixation and tracklength between EM fixation, may have explained the differences in ISS between EMR and normal Ss, on the verbally directed tasks. However, no group differences in duration and tracklength were

recorded suggesting that the greater ISS of the normal Ss, on the verbally directed tasks, was the result of giving more looking responses to areas of the stimulus material of high information content, than did the EMRs. Further, while differences in ISS between EMR and normal Ss were not significant on the non-directed search task, the fact that the EMRs recorded more unscorable frames on this task, than did normal Ss, indicated that the EMRs required more time (frames) in which to attain an ISS comparable to that of the normal Ss. These results are somewhat consistent with Shif's (1969) conclusions and those in Rosenberg's (1961) study which suggested that the rate of perceptual activity may be functionally related to degree of mental deficiency. The results, on the other hand, may also reflect the position which maintains that the learning difficulties of moderately retarded children are of perceptual-motor origin and indicate their inability to direct EMs toward relevant stimulus cues, rather than being indicative of a slow rate of learning (House and Zeaman, 1967; O'Connor and Hermelin, 1963). Further research will be required in order to clarify the validity of these latter two assumptions for the looking behavior of EMR children.

Differences in EM measures between non-directed and verbally directed search tasks provided further evidence of differences in the visual search behavior of EMR and normal children. While EMR and normal Ss did not record significant differences in ISS and unscorable frames between NDS and DS-RP task conditions, under the three second criterion, removing the effects of the unscorable frames

from the data revealed that only the normal Ss had obtained a significantly greater ISS on the DS-RP task, as compared to the NDS task condition. Further, the normal Ss also recorded a shorter duration of fixation and longer tracklength on the DS-RP task, as compared to the NDS task, while similar differences were not significant for the EMR group. This suggested that the greater ISS attained by normal Ss on the DS-RP task may be attributed to increased EM activity; an explanation which also appears to be consistent with the results of the vigilance study conducted by Mackworth, Kaplan and Metlay (1964) in which Ss recording a greater frequency of EM fixation detected more signal stimuli.

Both EMR and normal Ss recorded a significantly greater ISS on the NDS and DS-RP task conditions than was recorded on the DS-IP task, under the three second and 30 scorable frame criteria. Similarly, both groups recorded fewer unscorable frames on NDS and DS-RP tasks as compared to the DS-IP task condition. Increased EM activity, associated with shorter duration of fixation and longer tracklength, was characteristic of EMR and normal Ss' looking behavior on the DS-IP task in relation to both NDS and DS-RP task conditions. While increased EM activity may have contributed to the greater number of unscorable frames and hence the lower ISS recorded by EMR and normal Ss on the DS-IP, as compared to the NDS and DS-RP tasks, it is more likely that these differences are both task and stimulus specific.

Alternative phenomena, of a methodological nature, may also

have had a significant effect on the variability of the EM measures between task conditions. First, the content of the stimulus pictures used in conjunction with the NDS and DS-RP tasks was similar, and the criteria under which the judges assigned an ISS to the NDS and DS-RP stimulus material were not appreciably different. However, the DS-IP stimulus pictures and criteria used to assign an ISS to these pictures differed from the NDS and DS-RP tasks. As a result the DS-IP stimuli would have contained fewer cells of high information content, relative to the NDS and DS-RP stimuli, from which the Ss could have obtained an equivalent ISS were their looking responses to have remained constant over the three task conditions. Secondly, a significantly greater rate of EM activity was manifest by both groups under the DS-IP task, and may have resulted in some loss of calibration. Thus very rapidly moving EMs may not have been clearly distinguishable, recorded as unscorable, hence reducing the ISS. Thirdly, the NDS and ND-PS task conditions always preceded the two verbally directed tasks, in the experimental procedure. Thus the Ss may have been experiencing a measure of fatigue at the time their EMs were being recorded under the DS-RP and DS-IP tasks, hence reducing potentially greater variability in the EM measures, as compared to the NDS task condition. Finally, there may be good reason to caution interpretation of the absolute value of the ISS variable in relation to the type of cognitive activity required by the task condition. More specifically, there may be no reason to assume that a numerically large ISS value

is highly correlated with correct solution on an incomplete picture task, nor with the qualitative nature of short-term memory following a recall task. Thus it is likely that the absolute value of the ISS variable is both task and stimulus specific, and further research will be required to clarify this assumption.

Generally, the absence of any significant interaction between groups and task conditions, as well as significant differences between EMR and normal _Ss_ in duration and tracklength, over non-directed and verbally directed search tasks, suggests that these task conditions were having a similar effect on the looking behavior of both groups. The most important variable, serving to differentiate the EMR and normal _Ss_ with respect to their ISS, appeared to be the number of unscorable frames recorded by the EMRs over all three task conditions. An examination of the data revealed that the normal _Ss_ had obtained a significantly greater ISS during the first second ($p = .0008$) and 10 scorable frames ($p = .001$) of EM recording, than did the EMRs. Also, fewer unscorable frames ($p = .04$) had been recorded by normal _Ss_ during this same period. While no significant differences in unscorable frames were recorded between task conditions, during the first second, it appeared that the EMRs had experienced a measure of distraction which delayed initial responses to the stimulus content, hence significantly lowering their ISS. Since auditory stimuli were masked during EM recording it appeared that a major source of distracting stimuli could be attributed to the action of removing the

calibration card to expose the stimulus material. This explanation seems most viable due to the difficulty experienced in maintaining the retarded children's EM fixation prior to calibration. A considerable amount of prompting was required with the EMRs before their EMs were sufficiently controlled to permit reliable calibration. Thus the empirical results are likely masking even greater differences in the looking behaviors of the two groups due to the initial training effect afforded the EMR children. Furthermore, differences in the looking responses of the two groups, under the verbally directed tasks, may have been substantially reduced as a result of practice effects afforded the Ss under the NDS and ND-PS tasks, which preceded the verbally directed tasks for each S.

If the removal of the calibration card were a greater source of distraction for the EMRs than for normal Ss, during the first second of EM recording, the effect would appear to be congruent with the conclusion of Luria and Vinogradova (1963) that retarded children are more susceptible to the effects of strong, but often irrelevant stimuli, than are normal children; the retardate experiencing more difficulty habituating their orienting responses to such stimuli. The results, however, cannot be interpreted as substantially disproving Shif's (1969) conclusion that the perceptual activity of the retarded child becomes more efficient under the influence of verbal instructions.

Under the non-directed prolonged search task, differences in ISS between EMR and normal Ss favored the normal children. Both

groups recorded a substantially lower ISS during the final period of EM recording, than was obtained during the initial period. This appears to have been the result of the greater number of unscorable frames recorded during the final period, since no differences in EM activity associated with duration and tracklength were evident between EMR and normal Ss.

Removing the effects of gross inattentive looking responses (unscorable frames) from the data revealed that both EMR and normal Ss recorded a longer duration and shorter tracklength during the final period, than was recorded over the initial 30 scorable frames of the ND-PS task. Furthermore, the difference in ISS between the initial and final period of EM recording, was significantly lower for the EMRs than was the corresponding difference for normal Ss. Reduced EM activity during the final period of the ND-PS task would have contributed to the lower ISS recorded by both groups, yet it would also appear that the EMRs were giving fewer looking responses to areas of the stimuli of high information value than did the normal Ss, during the final period of the task condition. In addition, the fact that the EMRs recorded more unscorable frames than normal Ss, during the final period, suggests that they may have sustained a degree of habituation of their looking responses to the stimulus material during this period. Another possible, but not necessarily alternative explanation for the greater number of unscorable frames for the EMRs might be that there was a greater loss in calibration for the EMR than for the normal Ss. The explanation in terms of habituation would be

consistent with Luria's (1963) position that retarded children fail to sustain their orienting responses to certain types of stimuli. The explicit nature of EM activity under conditions of habituation, however, requires further experimental investigation.

Implications

The implications of the present study would appear to be most relevant for the areas of methodology and curriculum materials used in the education of retarded children.

With respect to methodology, a practical implication of this study bears upon the use of visual aids. We may suppose that in the teaching of retarded children, the directing of attention through the use of attractive visual aids will be less successful than with normal children in assuring the input of relevant information. More thoughtful use of visual aid material may be required in work with EMR children. Further, the quality of the retarded child's visual search behavior would appear to become even more tenuous as the qualitative and quantitative nature of extraneous stimuli, and length of exposure to the stimulus material, is increased. Thus the adoption of consistent administrative procedures, for presenting visual materials, which effectively reduce the effects of competing stimuli due to their routine nature would be recommended. Also evaluative procedures which consistently determine the extent to which relevant stimulus cues are being attended to, prior to evaluation of the quality of cognitive processing, may facilitate the learning of retarded children. These

procedures would be particularly recommended in the case in which stimulus materials are being repeated for the purpose of reinforcing the learning of concepts, due to the ease of habituation of retarded children under such conditions. In effect, then, the use of a variety of materials to teach the same concept may be more effective than the repeated or prolonged use of a few materials.

While procedures are required which reduce the distracting influence of extraneous stimuli on the retarded child, the use of attention-getting cues to highlight the most informative areas of the stimulus material was suggested by this study. Thus the fact that the retarded child is looking at the stimulus material does not necessarily guarantee that this child is selectively attending to relevant information sufficiently to be meaningfully learned. Caution would be advised, however, in the use of extreme types of attention eliciting mechanisms which may actually prevent the assimilation of information they are designed to illustrate due to the retarded child's inability to habituate their looking responses to unexpected stimuli.

The results of this study indicated that retarded children experienced more difficulty in controlling their visual search behavior, than did normal children. A developmental study would appear to be required, however, to determine whether the attention deficit of the retarded child is of perceptual-motor origin, thus reflecting a slower developmental rate and hence amenable to acceleration, or the result of perceptual dysfunctioning which limits the

degree to which training procedures may permanently correct such a deficiency. In either event the results of this study would suggest the augmentation of perceptual training procedures, and perhaps the incorporation of operant conditioning techniques, in the education of retarded children. For example, perceptual training involving instructions to detect likenesses and differences, note details, and follow directions in visual materials may not only provide the retarded child with more efficient visual search strategies and better control its looking responses, but effectively increase this child's span of attention, making the learning more efficient and permanent.

Summary

The purpose of the present study was to determine whether differences existed in the selective attentive behavior between EMR and normal children, using corneally reflected eye movements (EMs) as the dependent variable.

A review of literature concerning attentional deficiency in retarded children, and eye-movement studies of the perceptual activity of retarded and normal children, suggested that retarded children not only experience difficulty controlling their looking responses and selecting relevant stimulus cues, but habituate their responses to stimuli of certain intensities much more quickly than do normal children. Further, verbal signal stimuli do not maintain the active attention of retarded children in the same manner as in normal children. Thus the following postulates were suggested:

1. Normal children will show more effective looking responses, than EMR children, under relatively non-directed search, and verbally directed search tasks.
2. Normal children will show more effective looking responses, than EMR children, under non-directed prolonged exposure to repeated stimuli.

It was hypothesized that the normal Ss would record a significantly (1) greater mean ISS, (2) fewer unscorable frames, (3) longer duration of EM fixation, and (4) shorter tracklength between fixations, than EMR children, with respect to each of the postulates.

Thirty EMR and 30 normal children, nine to twelve years of age, were presented picture stimuli under (1) a non-directed search (NDS) task, (2) verbally directed picture recall (DS-RP) and incomplete picture (DS-IP) search tasks, and (3) a non-directed prolonged search (ND-PS) task. The EMs of the two groups were compared under two different response criteria. First, a three second criterion was used with respect to ISS and unscorable frame variables to determine whether the effects of any gross inattentive EMs (unscorable frames) would serve to differentiate the two groups with respect to their looking behavior. Secondly, a 30 scorable frame criterion was used to determine whether differences in the looking behavior, between EMR and normal children, may be evident in ISS, duration and tracklength variables when the effects of the inattentive looking responses were deleted from the data.

The results indicated that under the three second criterion normal Ss recorded a greater ISS and fewer unscorable frames, than did EMRs, on all task conditions. Thus the normal children gave more looking responses than EMRs to the stimulus material, as a whole, hence the greater ISS. When the effects of the unscorable frames were removed (30 scorable frame criterion) normal Ss again recorded a greater ISS than the EMRs, with the exception of the NDS task condition. The fact, however, that the EMRs recorded more unscorable frames on the NDS task, than did normal Ss, indicated that the EMRs required more time (frames) to attain a comparable ISS. The absence of any significant differences between EMR and normal Ss in duration and tracklength suggested that the greater ISS recorded by normal Ss may be attributed to more looking responses to areas of the stimuli of high information content, as compared to the visual search behavior of the EMR children. Generally, the visual search behavior of EMR and normal Ss was quite similar under NDS, DS-RP and DS-IP task conditions. The significantly greater number of unscorable frames and substantially lower ISS recorded by the EMRs, during the first second, appeared to be an important factor in differentiating the two groups; and may be due to a measure of distracting stimuli afforded the EMRs as a result of stimulus picture presentation.

The normal Ss recorded a greater ISS and fewer unscorable frames during the final period of the ND-PS task condition. No

significant differences in duration and tracklength were recorded between EMR and normal Ss, during the final period, but reduced EM activity was evident in the visual search behavior of both groups over the final period, in comparison to the initial period of the task conditions. Further, the fact that the EMRs recorded more unscorable frames than normal Ss, during the final period, suggests that they sustained a measure of habituation.

It was concluded that EMR children experience more difficulty, than normal children, in controlling their looking responses. Such behavior was regarded as representing a basic difficulty in the effectiveness of the EMRs selective attention behavior.

Implications for instructional procedures and materials to be used with retarded children were mentioned. Specifically, consistancy of presentation to reduce effects of competing stimuli, and perceptual training involving the following of directions, noting details, and detecting likenesses and differences in pictorial materials was suggested as possible methods of improving the selective attentive behavior of EMR children. Further investigations of a developmental nature were suggested to determine whether differences in the looking responses of retarded and normal children may be more clearly attributed to general ontogenetic rate of perceptual development, or to dysfunctioning of perceptual processes.

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APPENDIX A

Description of the X-Y Plotter
and Scoring Procedure

Description of the X-Y Plotter and Scoring Procedure

The 16 mm. movie film of a S's recorded EMs was placed on an L-W Photo Optical Data Analyzer (Model 224-A) which permitted manual presentation of the film frame by frame. The data analyzer projected each frame onto a ground glass projection screen which consisted of a calibrated field of voltage readings ranging from 0 to 10 volts, and any particular point on this field could be specified by its X and Y coordinates. A conversion machine then interpreted the X-Y voltage readings, numerically, and transferred these coordinates to an IBM punch-card machine. Both the calibrated screen and the conversion machine represent the X-Y Plotter. During film scoring the corneally reflected light spot on each frame was located on the screen and its coordinates punched directly onto IBM cards in the form of voltage readings. A computer program was then used to translate the voltage readings into the variables of duration, tracklength, unscorable frames and ISS.

The scoring procedure consisted of first obtaining the X and Y coordinates of the area of the corners of the visual stimulus. These coordinates were obtained from the calibration card which was presented prior to each stimulus picture presentation. The X-Y coordinates of the four corners of the calibration card were recorded in order of top left corner to top right corner to bottom right and finally bottom left. These coordinates established the limits to the visible area of the stimulus material and provided a means of recording

unscorable EMs. A position on the extreme bottom left corner was selected to indicate unscorable frames and was identified by a specific voltage reading on the IBM cards. These frames could later be deleted from the data under the 30 scorable frame criterion.

The particular procedure selected to indicate unscorable frames, however, resulted in an artifact being added into the duration and tracklength variables under the 3 second criterion. In effect, duration of fixation was increased each time that successive unscorable frames appeared, due to the stationary position used to identify an unscorable frame. Thus although a succession of unscorable light spots may not have constituted a single fixation, the method used to identify them would have, in fact, scored them as a single fixation thus incrementing the duration variable. The tracklength variable was also artifactually increased due to the procedure used to identify unscorable frames. It appeared that this increment may constitute the distance moved from the last scorable fixation to the edge of the picture stimulus. Both the direction and distance of the move would depend upon the location of the last scorable frame and the specific position used to identify an unscorable frame. As a result, then, both duration and tracklength were measured under the scorable frame criterion which was not affected by the particular biases mentioned.

APPENDIX B

Instructions for Judges' ISS Rating

Instructions for Judges Giving ISS Rating

The stimulus pictures used with respect to the NDS task were similar, but not identical, to those used under the RP task condition, hence the instructions provided for the 10 judges for both these tasks were the same:

(1) "Each cell in this picture is to receive a score from 0 (lowest) to 5 (highest) depending upon the amount of information you feel the cell contributes to the picture as a whole, relative to the other cells in the picture.

(2) An approach to rating the cells which you may find helpful is:

(a) Locate what you think is the highest information content area(s) in the picture and assign this cell(s) the appropriate weighting.

(b) Locate the cell(s) which you think contribute little or no information to the picture as a whole, and assign this cell(s) the appropriate weighting.

(c) Rate the remaining cells in the picture relative to their proximity to and importance for cells of high information content."

The instructions for rating the stimulus pictures under the IP task differed from those given for the NDS and RP tasks only in that the cell(s) receiving the highest rating would centre around the area where the missing element was located. Also, the judges were asked to rate any obvious cue as to the nature of the missing element according to its relative importance.

APPENDIX C

Task Instructions Given to Subjects

Task Instructions Given to the Subjects

Non-directed Search (NDS) and Non-directed Prolonged Search (NDPS)

The following instructions were given at the beginning of the ND-S task, and applied to the ND-PS task, as well, since the ND-PS task was a continuation of the NDS task condition.

> "I am going to show you some pictures which you may look at. I want you to do your very best to keep your head still while I am showing you the pictures. That's easy, isn't it? Just sit as still as can be, and I shall put some different pictures on the screen. Are you ready now? Look straight ahead at the screen and look at the cross in the center of the circle before we start."

Directed Search-Incomplete Picture (DS-IP)

Prior to the commencement of this task each subject was presented a sample picture to determine if they understood the nature of the task condition.

> "I am going to show you some more pictures now and I want you to tell me what part is missing, just like we did a minute ago. Look carefully at the pictures, find out what is missing, and as soon as you can tell me, shut your eyes. Have you got that? As soon as you have found out what is missing in the picture,

shut your eyes and I will know that you have got the answer. Let me tell you again. Look at the picture. Find out what part is missing - then close your eyes as soon as you have the answer. Good. Let's look at the cross in the center of the circle before we start."

Directed Search - Recall Picture (DS-RP)

"Now we have more pictures for you to look at. I want you to look at them carefully, then I am going to ask you to tell me all that you can remember about the pictures. That's easy, isn't it? Just look at the picture carefully, and then we shall ask you to tell us all about it. Let's look at the cross in the center of the circle before we start."

APPENDIX D

Duration and Tracklength Means and Analysis of Variance for the 30 Scorable Frame Criterion under the NDS, DS-IP and DS-RP Task Conditions

Duration and Tracklength Means for 30 Scorable Frame Criterion, and Analysis of Variance

(a) Duration

(i) Group Means

Group	N	NDS	DS-IP	DS-RP
EMR	30	0.311	0.229	0.287
Normal	30	0.329	0.246	0.242

(ii) Summary Analysis of Variance

Source	df	MS	F	p
Between Subjects	59			
Groups (A)	1	0.001	0.013	0.910
Subj. w. Grps.	58	0.045		
Within Subjects	120			
Tasks (B)	2	0.106	5.044	0.008
A x B	2	0.020	0.930	0.397
B x Subj. w. Grps.	116	0.021		

(b) Tracklength

(i) Group Means

Group	N	NDS	DS-IP	DS-RP
EMR	30	12.868	14.912	13.882
Normal	30	12.793	16.478	14.178

(ii) Summary Analysis of Variance

Source	df	MS	F	p
Between Subjects	59			
Groups (A)	1	15.959	0.52	0.473
Subj. w. Grps.	58	30.547		
Within Subjects	120			
Tasks (B)	2	124.124	8.68	0.000
A x B	2	11.129	0.778	0.462
B x Subj. w. Grps.	116	14.301		

APPENDIX E

Duration and Tracklength Means and Analysis of Variance for Initial and Final 30 Scorable Frames of the Prolonged Search Task

Duration and Tracklength Means for Initial and
Final 30 Scorable Frames of Prolonged Search
Task, and Analysis of Variance

(a) Duration

(i) Group Means

Group	N	Initial	Final
EMR	30	0.311	0.623
Normal	30	0.329	0.641

(ii) Summary Analysis of Variance

Source	df	MS	F	p
Between Subjects	59			
Groups (A)	1	0.010	0.045	0.833
Subj. w. Grps.	58	0.219		
Within Subjects	60			
Tasks (B)	1	2.922	17.658	0.000
A x B	1	0.000	0.000	0.995
B x Subj. w. Grps.	58	0.165		

(b) Tracklength

(i) Group Means

Group	N	Initial	Final
EMR	30	12,868	6.703
Normal	30	12.793	7.847

(ii) Summary Analysis of Variance

Source	df	MS	F	p
Between Subjects	59			
Groups (A)	1	8.547	0.27	0.604
Subj. w. Grps.	58	31.395		
Within Subjects	60			
Tasks (B)	1	925.928	41.970	0.000
A x B	1	11.155	0.506	0.479
B x Subj. w. Grps.	58	22.062		

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